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RESEARCH PROJECT REPORT
CONTRACT NO. PX7029-1-0114
SEPTEMBER, 1980 - AUGUST, 1981

WATER QUALITY MONITORING IN THE BIG THICKET NATIONAL PRESERVE, BIG SANDY CREEK UNIT

by

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for

UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE
SOUTHWESTERN REGION

and

LAMAR UNIVERSITY

BIG THICKET NATIONAL PRESERVE

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REFERENCE

ABSTRACT

Physicochemical parameters, bacteria and benthic macroinvertebrates of Big Sandy Creek in the Big Thicket National Preserve were studied from September, 1980 to August, 1981.

Physicochemical conditions indicated good water quality, with extremes often coinciding with extremes of discharge. All parameters were within the ranges expected for clean water streams in southeast Texas.

Bacterial contaminations in Big Sandy Creek was slight and should be safe for contact recreation.

A total of 4076 benthic macroinvertebrate organisms constituting 171 taxa were collected. Dominant organisms included Tanytarsus sp. (13.3%), Palpomyia sp. (9.0%), and Limnodrilus hoffmeisteri (8.66%).

Diversity ($\bar{d}$) values of all collections ranged from 2.48 to 4.53. Annual diversity ($\bar{d}$) was high for all stations indicating very little stress on the benthic fauna.

Sorenson's (1948) index of similarity indicated that all stations had similar faunal composition, except Station BS-4 which had a different substrate and was in a much smaller stream.

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INTRODUCTION

The Big Thicket National Preserve was established by Public Law 93-439 in October, 1974. It comprises 34,217.4 hectares (84,550 acres) in southeast Texas, and consists of eight land units and four river or stream corridors. It is expected that recreational use of the area, as well as development outside the preserve but in the watersheds, will increase and this will have the potential of altering water quality in the preserve. In order to evaluate water quality changes that may take place, it is necessary to obtain baseline data on present water quality.

Cole (1966), in his review of limnological studies of Texas, did not list any studies on streams in the Big Thicket. A review of limnological and hydrological research in the Big Thicket National Preserve area was reported by Harrel and Watson (1975). Harrel (1976,1977) reported baseline water quality data on streams flowing through five units of the preserve. Harrel et al. (1976) reported on water quality and benthic macroinvertebrates in the estuarine portion of the Neches River and Pine Island Bayou, some of which are in the preserve. Kost (1977) studied the effect of lumbering activities on water quality and benthic macroinvertebrates in streams of the Beech Creek Unit of the preserve. Lewis and Harrel (1978) reported on macrobenthos and physicochemical conditions in Village Creek, which provides drainage for four of the eight units in the preserve. Water quality, including bacteriological data and benthic macroinvertebrates were studied by Darville and Harrel (1980) in Little Pine Island Bayou and Pine Island Bayou in the preserve. Commander (1978) reported on fecal coliform load and densities

of coliform organisms in Pine Island Bayou. Bacteriological, physicochemical, and benthic macroinvertebrates were studied in the Menard Creek Corridor by Bass and Harrel (1981), which is just south of the present study area. Commander (1980) reported on water quality and macrobenthos of streams in the Turkey Creek Unit of the preserve.

Many investigators have shown that physicochemical and biological data may differ widely when several factors interact to affect water quality.

Winslow and Hunnewell (1902) were the first to use bacteria as indicators of fecal contamination. They reported that streptococci bacteria occurred in the feces of warm-blooded animals and in waters receiving their feces. The isolation of fecal coliform and fecal streptococci is used to illustrate the potential presence of intestinal pathogens. Gallagher and Spino (1968) reproted that pathogenic Salmonella were isolated from fecal coliform densities of less than 150/100 ml after a 99% reduction of fecal coliform. Geldrich and Kenner (1969) reported on fecal coliform (FC) to fecal streptococci (FS) ratios and interpreted their meaning as:

FC/FS 0.7	Animal fecal contamination other than human
FC/FS = 0.7-4.0	Mixture of animal and human fecal contamination
FC/FS 4.0	Mostly human fecal contamination

Gallagher and Spino (1968) stated that whenever the FC/FS ratio was applied, all factors affecting the growth and survival of bacteria in the stream should be taken into consideration.

Physicochemical and bacteriological data indicate water quality only at the time of sampling, while macrobenthos reflect both present and past

conditions.

Community structure of benthic macroinvertebrates has frequently been used to evaluate water quality (Gaufin and Tarzwell, 1956; Wilhm and Dorris, 1966; Harrel and Dorris, 1968; Harrel 1969). Keup et al. (1966) stated the following characteristics of macrobenthic organisms which make them useful for water quality studies: (1) long life cycles which may reflect conditions for an extended period of time, (2) low motility, (3) various ranges of tolerances to varying environmental conditions, and (4) central positions in aquatic food webs.

Many researchers have used mathematical indices to analyze community structure of benthic macroinvertebrates. Shannon's (1948) diversity index ($\bar{d}$) is possibly the most widely accepted. It was first used in ecological studies by Patten (1962) and later modified by Wilhm and Dorris (1968). This index reflects evenness of taxa distribution, is dimensionless, and is relatively independent of sample size (Wilhm and Dorris, 1968). Low values may indicate few taxa and stressed conditions while high values may indicate many taxa and non-stressed conditions. Pertinent regional studies that have used $\bar{d}$ to express community structure are Harrel and Duplechin (1976), Kost (1977), Sala et al. (1977), Cover and Harrel (1978), Lewis and Harrel (1978), Darville and Harrel (1980), Commander (1980), and Bass and Harrel (1981).

Sorenson's index of similarity (1948) may be used to compare faunal similarity between two stations. Values may vary from zero for two stations with no taxa in common, to 1.0 for two samples with identical faunal composition.

The objectives of this study were: (1) to obtain baseline water quality data for Big Sandy Creek, (2) to establish downstream and seasonal

trends in water quality, and (3) to locate existing and potential sites of pollution.

DESCRIPTION OF AREA AND SAMPLING STATIONS

Big Sandy Creek originates in northern Polk County and flows southeast into Hardin County where it joins Village Creek. Big Sandy Creek's total length is approximately 64.4 km (40.0 miles) with approximately 34.6 km (21.5 miles) inside the preserve. The entire Big Sandy Creek Unit is located in Polk County. Inside the preserve, the main channel of Big Sandy Creek has a gradient of 0.53 m/km. A small tributary, on which Station BS-4 is located, is approximately 6.4 km (4.0 miles) long and has a gradient of 5.7 m/km.

The Big Sandy Unit lies within the Willis Geologic Formation and has a narrow strip of Pleistocene alluvium directly adjacent to the creek (Barnes, 1968). Soils of the Segno-Hockley Bernaldo Association occur within the upland areas of the unit. Mantachie soils occur along the creek bottoms (United States Department of Agriculture, 1972).

The vegetation in Big Sandy Unit is diverse, with forest types of Pine forest, Pine Sandhill, Upper Slope Pine Oak, Mid Slope Oak Pine, Lower Slope Hardwood Pine, Stream Floodplain, and Baygall (Marks and Harcombe, 1978). A few of the dominant overstory trees are Pinus taeda (loblolly pine), Pinus echinata (shortleaf pine), Quercus spp. (oaks), Liquidambar straciflua (sweetgum), and Magnolia grandiflora (southern magnolia). Other common species are Pinus plaustris (long-leaf pine), Nyssa sylvatica (blackgum), Taxodium distichum (bald cypress), and Nyssa aquatica (water typelo). Understory vegetation consists of Crataegus spp. (hawthorns), Cyrilla racemiflora (titi), Ilex coriacea (gallberry holly), Carpinus caroliniana (ironwood), Cornus florida (flowering dogwood), and Fraxinus caroliniana (carolina ash).

Five stream sampling stations were established in the Big Sandy Creek Unit (Figure 1).

Station BS-1 - boundary between the unit and the Indian Reservation

Station BS-2 - approximately 100 m downstream from Hwy 1276 bridge that crosses the northern section of the unit.

Station BS-3 - approximately 20 m downstream from bridge on dirt road near the Lilly home.

Station BS-4 - small tributary of Big Sandy, approximately 2.4 km (1.5 mi) east of Station BS-3, about 10 m upstream from bridge crossing road to the Lilly home.

Station BS-5 - approximately 20 m upstream from Hwy 1276 bridge near southeast boundary of the unit.

The substrate at all stations except Station BS-4 was primarily fine to coarse sand, and silt with some plant detritus along the margins. Station BS-4, on the small tributary, had a substrate of pebbles or gravel mixed with coarse sand.

Stream depth ranged from approximately 20 cm during low flow conditions at Stations BS-1 and BS-4 to about 3 m during flood state at the other stations.

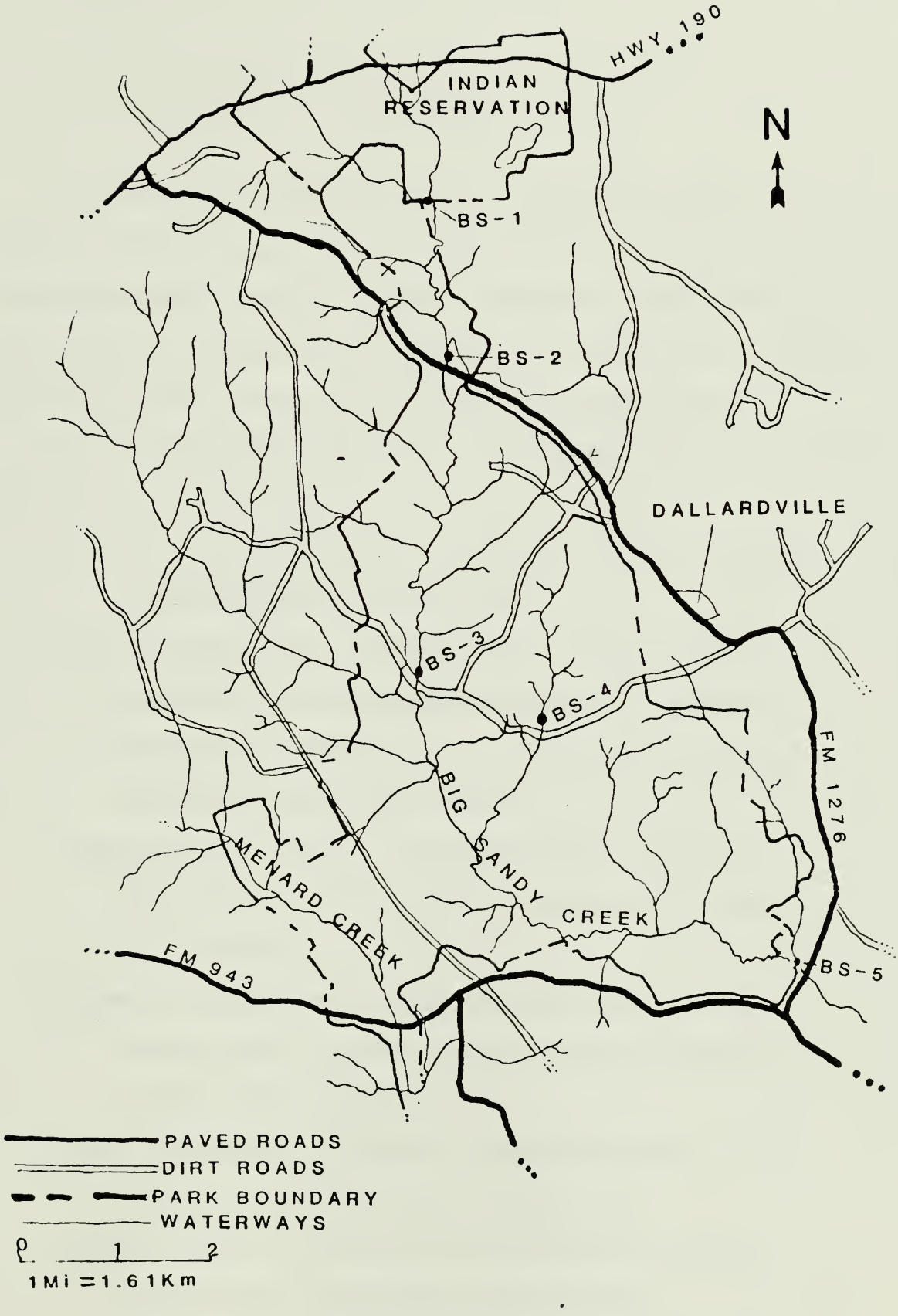

Figure 1. Big Sandy Creek Unit and sampling stations

METHODS

Physicochemical data and bacteria were collected monthly from September, 1980 to August, 1981. Benthic macroinvertebrates were collected seasonally (Table 1). Standard BOD bottles were submerged to obtain water for physicochemical analysis. Sterilized 100 ml screw-cap glass bottles were used to collect water for bacteria counts.

Data obtained from each station and methods of analyses are listed below:

Water temperature - Centigrade thermometer or Yellow Springs Instrument Model 57 Oxygen Meter.

Dissolved Oxygen (O_2) - Yellow Springs Instrument Model 57 Oxygen Meter and the azide modification of the Winkler method which involves titration with phenylarsine oxide using starch indicator solution.

Oxygen Percent Saturation - Calculation using temperature, dissolved oxygen concentration, and tables of Truesdale et al. (1955)

Biochemical Oxygen Demand (BOD) - Determination of oxygen concentration in samples before and after incubation in dark at 20 C for five days.

Carbon Dioxide (CO_2) - Titration with 0.0227N sodium hydroxide to the phenolphthalein end-point.

Alkalinity (ALK) - Titration with 0.02N sulfuric acid to the brom cresol green-methyl red end-point.

Table 1

Collection Dates

Date	Physicochemical Data	Benthic Data
1980		
September 7	*	
October 11	*	*
November 15	*	
December 14	*	
1981		
January 18	*	*
February 21	*	
March 15	*	
April 11	*	*
May 9	*	
June 16	*	
July 25	*	*
August 26	*	

ph - Hellige pH comparator

Specific Conductance (Spec Cond) - Lab Line Lectro Mho meter.

Chlorides (Chlor) - The Mohr argentometric method that involves titration with 0.014N silver nitrate solution and chromate indicators.

Turbidity - B & L Spectronic "20" spectrophotometer and a turbidity table by Hach Chemical Company (1975).

Apparent Color - Hach Chemical Company direct reading colorimeter.

Orthophosphate (PO_4) - B & L Spectonic "20" and the Hach Modification of the Ascorbic acid method.

Nitrate Nitrogen (NO_3) - B & L Spectronic "20" and the cadmium reduction method.

Ammonia Nitrogen (NH_4) - B & L Spectronic "20" and the Nessler method.

Iron, Total (Fe) - B & L Spectronic "20" and the 1, 10 - phenanthroline method.

Total Suspended Solids (TSS) - Filtration through 0.45 μ Millipore filters and the gravimetric method.

Total Dissolved Solids (TDS), Total Dissolved Organic Solids (TDO) and Total Dissolved Inorganic Solids (TDI) - Filter samples through 0.45 μ Millipore filters and evaporation at 100 C. The residue after evaporation is the TDS. Burning of the evaporated and the weighed

sample at 550 C leaves the TDI. The weight loss between evaporation and burning is the TDO.

Chlorophyll "a" (Chlor) - The method of Richards and Thompson (1952) as modified by Odum et al. (1958) using a B & L Spectronic "20". The chlorophyll was extracted in an acetone solution and the optical density was determined at 665 nm and substituting the formula:

$$\text{Chlor mg/l} = \text{O.D.}_{665}(13.4)\frac{\text{ml of acetone}}{1000\ (\text{liters of water})}$$

Bacteria - Numbers of fecal coliform and fecal streptococci bacteria were determined by membrane filter techniques (American Public Health Association, 1976). Ten ml and 25 ml water samples were filtered through 0.45 μ, gridded, 47 mm Millipore filters. The filters were placed on pads saturated with EC media for fecal coliform growth or KF media for fecal streptococci growth, and incubated in plastic Petri plates. The number of colonies on each plate was counted after the fecal coliform were incubated submerged in a water bath at 44.5 C for 24 hours, and the fecal streptococci were incubated at 37.5 C for 48 hours. The numbers of fecal coliform and fecal streptococci per 100 ml were used to calculate the fecal coliform to fecal streptococci (FC/FS) ratios (Geldreich and Kenner, 1969).

Benthic Macroinvertebrates - Macrobenthos were collected with a petite Ponar grab (15.24 cm x 15.24 cm). Six grabs were taken at each station, washed in a #30 sieve bucket and preserved with formalin and Rose bengal dye. In the laboratory, the samples were washed in a #30 U. S. Standard Soil Sieve and the organisms were sorted, identified and counted. Shannon's ($\bar{d}$) diversity index (1948) as proposed by Margalef (1958) and modified by Patten (1962) and Wilhm and Dorris (1968) was calculated for each station for each collection and for each station annually by the formula:

$$\bar{d} = -\sum \frac{(n_i)}{(n)} \log_2 \frac{(n_i)}{(n)}$$

where: $\bar{d}$ = diversity per individual

n_i = number of individuals of species i

n = total number of individuals

Sorenson's (1948) index of similarity was modified to compare the overlay of taxa between all pairs of stations by the formula:

$$S = \frac{2C}{A + B}$$

where: A = number of taxa at Station A

B = number of taxa at Station B

C = number of taxa common to both stations

PHYSICOCHEMICAL CONDITIONS

Discharge

Discharge data were not available for streams in the Big Sandy Creek Unit. Thus, stream discharge was estimated to be: (1) low - when the channel was less than one-fourth bankfull, (2) intermediate - when water was over one-fourth to three-fourths bankfull, (3) high - over three-fourths bankfull to bankfull, and (4) flood - when water rose out of the channel and flowed across the flood plain. Discharge conditions at Station BS-5 on the dates of collection are shown in Table 2. Discharge conditions were similar at all stations, except BS-4, during individual collection dates. Station BS-4 was in a small tributary off the main stream and always had low to intermediate discharge.

Temperature

Water temperature varied from 6 C in January at Station BS-1 and BS-2 to 26 C at all stations except BS-4 during July (Table 3, Appendix A). Temperatures varied from 1 C to 4 C between stations during the same collection dates. These differences can be attributed to differences in shading, water volume, and time of sampling.

Dissolved Oxygen and Biochemical Oxygen Demand

Dissolved oxygen concentration ranged from 3.6 mg/l (45% saturation) at Station BS-5 in July to 11.8 mg/l (100% saturation) in January, also at Station BS-5 (Table 3, Appendix A). Station BS-5 had the greatest annual fluctuation, while the least occurred at Station BS-4. The higher concentrations occurred during colder months.. Biochemical Oxygen Demand (BOD) was generally low at all stations. BOD ranged from zero at

Table 2

Stream Conditions on Dates of Collection at Station BS-5
from September 1980 to August 1981

Collection Date	Flow	Stream Conditions	Remarks
1980			
September 7	high	almost bank full	rain day before
October 11	low	¼ bank full	
November 15	low	¼ bank full	
December 14	intermediate	½ bank full	
1981			
January 18	low	¼ bank full	
February 21	low	¼ bank full	
March 15	high	almost bank full	
April 11	low	¼ bank full	
May 9	intermediate	½ bank full	rainy
June 16	flood	out of bank	
July 25	high	3/4 bank full	down after flood
August 26	low	¼ bank full	

Table 3

Extremes of Physicochemical Conditions, September 1980 - August 1981

Parameter	Station BS-1	BS-2	BS-3	BS-4	BS-5
Temperature (C)	6.0-26.0	6.1-26.0	6.0-26.0	9.2-23.0	7.0-26.0
Oxygen (mg/l)	6.1-11.4	5.8-11.6	5.3-11.6	5.8-10.4	3.6-11.8
% Saturation	69-95.9	71.5-96.4	63.4-96.2	68.0-97.3	45.1-100
BOD (mg/l)	0.1-3.9	0.3-4.1	0.0-3.5	0.0-2.2	0.1-3.7
CO_2 (mg/l)	3.5-10.5	4.0-10.0	3.5-12.0	9.0-14.5	2.5-16.5
Alkalinity (mg/l)	10.0-28.0	9.0-31.0	12.0-28.0	4.0-11.0	8.0-24.0
pH	5.6-6.8	5.4-6.5	5.6-6.4	4.5-5.6	5.1-6.9
Specific Conductance (μmhos/cm)	61-116	70-144	8.9-128	19-33	50-400
Chlorides (mg/l)	13.0-19.5	14.0-33.0	11.5-29.0	7.5-10.0	9.5-23.5
Turbidity (JTU)	39-104	44-104	32-112	22-73	30-106
Apparent Color (color units)	70-250	50-300	20-240	10-170	30-260
PO_4 (mg/l)	0.08-1.92	0.11-2.37	0.11-1.64	0.08-1.92	0.08-2.77
NH_4 (mg/l)	0.64-1.84	0.50-2.12	0.52-2.12	0.37-1.29	0.52-2.57

Table 3

Extremes of Physicochemical Conditions, September 1980 - August 1981

Parameter	Station BS-1	BS-2	BS-3	BS-4	BS-5
Temperature (C)	6.0-26.0	6.1-26.0	6.0-26.0	9.2-23.0	7.0-26.0
Oxygen (mg/l)	6.1-11.4	5.8-11.6	5.3-11.6	5.8-10.4	3.6-11.8
% Saturation	69-95.9	71.5-96.4	63.4-96.2	68.0-97.3	45.1-100
BOD (mg/l)	0.1-3.9	0.3-4.1	0.0-3.5	0.0-2.2	0.1-3.7
CO_2 (mg/l)	3.5-10.5	4.0-10.0	3.5-12.0	9.0-14.5	2.5-16.5
Alkalinity (mg/l)	10.0-28.0	9.0-31.0	12.0-28.0	4.0-11.0	8.0-24.0
pH	5.6-6.8	5.4-6.5	5.6-6.4	4.5-5.6	5.1-6.9
Specific Conductance (μmhos/cm)	61-116	70-144	8.9-128	19-33	50-400
Chlorides (mg/l)	13.0-19.5	14.0-33.0	11.5-29.0	7.5-10.0	9.5-23.5
Turbidity (JTU)	39-104	44-104	32-112	22-73	30-106
Apparent Color (color units)	70-250	50-300	20-240	10-170	30-260
PO_4 (mg/l)	0.08-1.92	0.11-2.37	0.11-1.64	0.08-1.92	0.08-2.77
NH_4 (mg/l)	0.64-1.84	0.50-2.12	0.52-2.12	0.37-1.29	0.52-2.57

Table 3 (Continued)

Parameter	Station BS-1	BS-2	BS-3	BS-4	BS-5
NO_3 (mg/1)	0.0-.006	0.0-.0053	0.0-.006	0.0-.0053	0.0-.0053
Fe (mg/1)	0.13-1.56	0.08-1.36	0.12-1.47	0.09-1.35	0.11-1.08
TSS (mg/1)	1.0-30.0	2.0-30.0	1.0-35.0	1.0-9.0	1.0-45.0
TDS (mg/1)	27.0-56.0	24.0-57.0	24.0-58.0	9.0-32.0	16.0-50.0
TDO (mg/1)	6.0-34.0	6.0-30.0	15.0-28.0	2.0-19.0	5.0-27.0
TDI (mg/1)	6.0-35.0	5.0-45.0	9.0-35.0	1.0-14.0	1.0-30.0
Chlorophyl "a" (mg/1)	0.0-0.02	0.0-0.06	0.0-0.05	0.0-0.03	0.0-0.03

Stations BS-3 in February and BS-4 in August to 4.1 mg/l at Station BS-2 in November (Table 3, Appendix A). These levels indicate clean water conditions.

Carbon Dioxide, Alkalinity, and pH

Carbon Dioxide concentrations varied from 2.5 mg/l in January at Station BS-5 to 16.5 mg/l in June also at Station BS-5 (Table 3, Appendix A). Carbon Dioxide concentrations increased from January to June due to increasing temperatures and decay rate. Only bicarbonate alkalinity was present, and concentrations ranged from 4 mg/l in October, November, June, and August at Station BS-4 to 31 mg/l in July at Station BS-2 (Table 3, Appendix A). Alkalinity was lower at Station BS-4 than any other station all year long. The pH values ranged from 4.5 at Station BS-4 in May to 6.9 at Station BS-5 in February (Table 3, Appendix A). No consistent seasonal or downstream trends were evident.

Conductivity and Chlorides

Conductivity ranged from 8.9 μmhos/cm at Station BS-3 in May to 400 μmhos/cm at Station BS-5 in January (Table 3, Appendix A). Chloride concentrations ranged from 7.5 mg/l at Stations BS-4 in February to 33 mg/l at Station BS-2 in January (Table 3, Appendix A). No trends were evident.

Turbidity and Apparent Color

Turbidity ranged from 22 JTU at Station BS-4 in August to 112 JTU at Station BS-3 in June (Table 3, Appendix A). Turbidity fluctuated with amount of discharge at time of collection. Station BS-4 had the lowest turbidity and discharge all year. Apparent Color ranged from 10 CU at Station BS-4 in January to 300 CU at Station BS-2 in May

(Table 3, Appendix A). Higher values were found during times of greater discharge or runoff.

Orthophosphate and Total Iron

Orthophosphate concentrations ranged from 0.08 mg/l at Station BS-1, BS-4, and BS-5 in October to 2.77 mg/l at Station BS-5 in July (Table 3, Appendix A). Total Iron concentrations varied from 0.08 mg/l at Station BS-2 in August to 1.56 mg/l at Station BS-1 in April (Table 3, Appendix A). No trends were evident.

Ammonia Nitrogen and Nitrate Nitrogen

Ammonia Nitrogen concentrations ranged from 0.37 mg/l at Station BS-4 in February and April to 2.57 mg/l at Station BS-5 in June (Table 3, Appendix A). Ammonia Nitrogen concentrations remain below 1 mg/l except for three months of the year, when long periods of little rain occurred. Nitrate Nitrogen concentrations ranged from zero at all stations in October to 0.006 mg/l at Station BS-1 and BS-3 in May and January (Table 3, Appendix A). The low concentrations of nitrates made it impossible to determine any seasonal or downstream trends.

Total Suspended and Dissolved Solids

Total Suspended Solids (TSS) ranged from 1 mg/l at all stations, except BS-2, to 45 mg/l at Station BS-5 in June (Table 3, Appendix A). Generally all stations had similar concentrations except Station BS-4, which always had very low values. Total Dissolved Solids (TDS) ranged from 9.0 mg/l at Station BS-4 in October to 58 mg/l at Station BS-3 in July (Table 3, Appendix A). The higher values fluctuated with amount of flow in the stream. Station BS-2 frequently had higher TDS concentrations than any of the other stations. Station BS-4 always had the

lowest concentrations. Total Dissolved Organics (TDO) ranged from 2 mg/l at Station BS-4 in December to 34 mg/l at Station BS-1 in June (Table 3, Appendix A). Total Dissolved Inorganic (TDI) concentrations ranged from 1 mg/l at Station BS-4 and BS-5 in October to 45 mg/l at Station BS-2 in December (Table 3, Appendix A). No seasonal or downstream trends were evident.

Chlorophyll "a"

Chlorophyll "a" concentration ranged from zero at all stations in September, October, and December to 0.06 mg/l at Station BS-2 in January (Table 3, Appendix A). These low concentrations were expected in heavily shaded streams with sand substrates.

BIOLOGICAL CONDITIONS

Bacteria

Numbers of fecal coliform bacteria ranged from zero at all stations, during one or more collection period, except Station BS-3, to 252/100 ml at Station BS-2 during June (Table 4). Numbers of fecal streptococci ranged from 40/100 ml in April at Station BS-3 to 2720/100 ml in November at BS-1 (Table 4).

The fecal coliform to fecal streptococci ratio (FC/FS) ranged from zero, at all stations when zero fecal coliforms occurred, to 1.11 at Station BS-3 during November (Table 4). Fifty-nine of the sixty individual samples had FC/FS ratios below 0.7 indicating contamination by warm-blooded animals other than human. There were no seasonal or downstream trends in bacteria numbers or FC/FS ratios.

Bacteria contamination was very slight and Big Sandy Creek should be safe for contact recreation.

Benthic Macroinvertebrates

A total of 4076 benthic macroinvertebrates distributed among 171 taxa were collected (Table 5, Appendix B). Major taxonomic groups included chironomids (49.9%, 57 spp.), oligochaetes (19.0%, 18 spp.), ceratopogonids (10.1%, 5 spp.), ephemeropterans (6.9%, 22 spp.), coleopterans (3.1%, 6 spp.), trichopterans (2.7%, 19 spp.), tipulids (2.3%, 3 spp.), odonates (1.4%, 10 spp.), pelecypods (1.3%, 7 spp.), and gastropods (1.2%, 4 spp.) which comprised 97.7% of the total fauna (Table 6).

The total numbers of taxa during each collection ranged from 73

Table 4

Numbers of Fecal Coliform (FC) and Fecal Streptococci (FS) and the FC/FS Ratio

Date		Station BS-1	BS-2	BS-3	BS-4	BS-5
September 7, 1980	FC	16	36	40	24	20
	FS	660	590	440	390	670
	FC/FS	0.02	0.06	0.09	0.06	0.03
October 20, 1980	FC	80	20	12	8	80
	FS	250	940	110	100	140
	FC/FS	0.32	0.02	0.11	0.08	0.57
November 15, 1980	FC	144	28	100	84	96
	FS	2720	970	90	350	170
	FC/FS	0.05	0.03	1.11	0.24	0.56
December 14, 1980	FC	40	136	132	80	28
	FS	2390	1260	150	680	280
	FC/FS	0.02	0.11	0.88	0.12	0.10
January 18, 1981	FC	0	0	4	0	24
	FS	70	150	90	490	360
	FC/FS	0	0	0.04	0	0.07
February 21, 1981	FC	54	48	4	8	16
	FS	120	136	100	716	56
	FC/FS	0.45	0.35	0.04	0.01	0.29
March 15, 1981	FC	84	32	40	0	12
	FS	620	330	220	100	370
	FC/FS	0.14	0.10	0.18	0	0.03
April 11, 1981	FC	40	44	16	16	36
	FS	290	300	40	140	100
	FC/FS	0.14	0.15	0.40	0.11	0.36
May 9, 1981	FC	168	92	40	80	52
	FS	540	460	490	300	410
	FC/FS	0.31	0.20	0.08	0.27	0.13
June 16, 1981	FC	12	252	8	52	28
	FS	570	590	420	610	460
	FC/FS	0.21	0.43	0.02	0.09	0.06
July 25, 1981	FC	60	0	8	4	0
	FS	1080	1360	370	2670	1550
	FC/FS	0.02	0	0.02	0.001	0

Table 4 (Continued)

Date		Station BS-1	BS-2	BS-3	BS-4	BS-5
August 26, 1981	FC	20	4	0	8	28
	FS	900	850	560	570	680
	FC/FS	0.02	0.005	0	0.01	0.04

Table 5

Annual List of Macrobenthos in Big Sandy Creek

Taxa	Station BS-1	BS-2	BS-3	BS-4	BS-5
Cnidaria					
Hydra sp.	1	2	3		1
Nemertea					
Prostoma rubrum	1	3		1	
Annelida					
Oligochaeta					
Naididae					
Nais variabilis		1		3	12
Nais simplex				1	25
Nais elinguis					1
Nais behnigi			2		
Dero nivea					1
Pristina breviseta				2	
Pristina longiseta leidyi				1	
Pristina longisoma					10
Pristina osborni				2	2
Bratislavia unidentata	1				1
unk. Naididae				1	1
Tubificidae					
Limnodrilus hoffmeisteri	6	96	159	46	45
Aulodrilus pigueti	3	4	16	21	
Peloscolex sp.	3	35	55	97	15
Tubifex sp.			4	3	1
Enchytraiidae					
Enchytraeus sp.	2			23	
Lubriculidae					
Eclipdrilus sp.	1		4	1	10
Lumbriculus variegatus		3	16	1	36
Hirudinea					
unk. Hirudinea		1			
Glossiphoniidae					
Helobdella punctatolineata					1
Rhynchobdellidae					
Actinobdella triannulata			1		4
Arthropoda					
Crustacea					
Amphipoda					
Gammarus sp.			15		1
Crangonyx sp.					7
Hyalella azteca					2
Decapoda					
Cambarellus puer	1	4	5		3
Palaemonetes kadiakensis					7
Hydracarnia					
unk. Hydracarnia	4				

Table 5 (Continued)

Taxa	Station BS-1	BS-2	BS-3	BS-4	BS-5
Insecta					
Collembola					
Isotomurus palustris			4		2
Plecoptera					
Perlidae					
Acroneuria sp.					3
Atoperla ephyre				1	
Perlodidae					
Isoperla sp.					1
Ephemeroptera					
Isonychia sp.	1	1			
Baetisca sp.	4	2			
Caenis sp.	7	14	5		9
Traverella sp.	3		1		
Parameletus sp.	5	4	2		2
Hexagenia limbata	28	18	32	10	11
Ametropus sp.				1	
Ephemerella sp.			5	2	3
Stenonema sp.		7	14	4	5
Choroterpes sp.		3	6	5	
Baetis sp.			1		5
Stenacron sp.	1				
Leptophlebia sp.		1			
Neoephermera sp.		5	12		4
Cloeon sp.		4	2		
Heptagenia sp.			6		
Leptohyphes sp.			3		
Paraleptophlebia sp.				1	7
Tricorythodes sp.					2
Brachycercus sp.			1		
Callibaetis sp.					7
unk. Ephemeroptera			2		
Odonata					
Anisoptera					
Progomphus sp.	6	1			1
Ophiogomphus sp.	2	2			
Gomphus sp.	1	1	7	5	3
Macromia sp.	1		1		2
Boyeria sp.					4
Hagenius brevistylus					1
Zygoptera					
Argia sp.			1		
Amphiagrion sp.	2	1	1	5	
Ischnura sp.		1		2	
Chromagrion conditium					5
Hemitera					
Hebridae					

Table 5 (Continued)

Taxa	Station BS-1	BS-2	BS-3	BS-4	BS-5
Hebrus sp.				1	
Megaloptera					
Sialidae					
Sialis sp.		1		1	
Corydalidae					
Corydalus cornutus			2		
Trichoptera					
Hydropsychidae					
Hydropsyche sp.	4		1		12
Cheumatopsyche sp.			1		
Leptonema sp.	1				
Hydroptilidae					
Stactobiella sp.				1	2
Oxyethira sp.	1		1		
Hydroptila sp.				1	
Orthotrichia sp.					1
Leptoceridae					
Oecetis sp.	5	4	2	6	
Ceraclea sp.				2	
Nectopsyche sp.	1			1	
Triaenodes sp.				3	
Limnephilidae					
Pycnopsyche sp.					1
Molannidae					
Molanna sp.				3	
Philoptamidae					
Chimarra sp.			2		
Phlycentropodidae					
Phylocentropus sp.	7	16	11		12
Nyctiophylax sp.				3	1
Polycentropus sp.	1	1			1
Neureclipsis sp.					1
Rhyacophilidae					
Atopsyche sp.			1		
Coleoptera					
Elmidae					
Dubiraphia sp.	42	18	22		20
Stenelmis humurosa	1				
Stenelmis sinuata		2			
Stenelmis sp.			4		5
Ancyronyx variegata		5			1
Macronychus sp.					4
Diptera					
Tipulidae					
Hexatoma sp.	60	2	10	12	6
Pedicia sp.			1		
Tipula sp.				1	

Table 5 (Continued)

Taxa	Station BS-1	BS-2	BS-3	BS-4	BS-5
Chironomidae					
Tanypodinae					
Ablabesmyia cinctipes	3	7	3	1	3
Ablabesmyia annulata	10	2	7	5	3
Ablabesmyia tarella	5	9	13	10	7
Ablabesmyia ornata	1	13	7	7	11
Ablabesmyia mallochi		9	1	1	5
Ablabesmyia parajanta	1	1			2
Ablabesmyia philosphagnos			1	2	
Conchapelopia sp.	1		2	2	1
Pentaneura sp.	1		2		1
Clinotanypus sp.	2		1		
Labrundina neopilosella		2	1		
Procladius sp.			1		
Diamesinae					
Diamesa sp.			1		
Chironominae					
Polypedilum convictum	2				9
Polypedilum ontario	7	6	12		9
Polypedilum halterale	7	3	42	13	25
Polypedilum fallax	2	7	68	17	23
Polypedilum illinoense		1			5
Tribelos fuscicornis	6	83	11	1	23
Phaenospectra obediens	1		1		
Cladotanytarsus sp.	152	25	47	72	16
Tanytarsus sp.	91	89	118	58	191
Pseudochironomus sp.	48	7	18		2
Xenochironomus sp.	1				
Zavrelia sp.	4	9	7	2	6
Microspectra sp.	2		3		
Stenochironomus sp.	1	5	3	9	
Paratanytarsus sp.	4	3			
Cryptochironomus blarina	7	1	10		
Cryptochironomus fulvus	2	5	19	9	17
Rheotanytarsus sp.		1	3		7
Parachironomus sp.		1			
Glyptotendipes sp.	2		10		7
Cryptotendipes sp.			9		1
Leptochironomus sp.		2	18	7	
Paracladopelma sp.			1		
Stictochironomus devinctus				9	
Microtendipes sp.	5	3	7	45	7
Paratendipes connectens			1		3
Robackia demeijerei	18		2	2	21
Chironominae (Sp.A.) Roback					1
Orthocladiinae					
Brillia sp.		2			

Table 5 (Continued)

Taxa	Station BS-1	BS-2	BS-3	BS-4	BS-5
Cricotopus remus	21	2	10	24	113
Cricotopus sp. 1				1	10
Cricotopus fulvus			1	12	
Cricotopus sp.					2
Psectrocladius sp.	1				
Microcricotopus sp.	1		1		
Cardiocladius sp.		1		2	5
Pseudorthocladius sp.	1			1	2
Orthocladius sp.	1				
Nanocladius crassicornus					1
Epoicocladius sp.					1
Rheocricotopus sp.			2	2	1
Parametricocnemus sp.			1	5	1
Metriocnemus sp.				1	
Krenosmittia sp.				1	
Ceratopogonidae					
Palpomyia sp.	117	86	61	44	58
Palpomyia tibialis	10	1			
Bezzia sp.	6	5	7	1	9
Stilobezzia sp.			5		1
Culicoides sp.			1		
Tabanidae					
Tabanus sp.	1	4		2	1
Haematopota sp.					2
Empididae					
unk. Empididae					1
Mollusca					
Gastropoda					
Amnicola sp.	3		26		5
Gyralus sp.	1		1		
Ferrissia sp.		4	2	2	4
Viviparus sp.					1
Pelecypoda					
Sphaerium sp.	4	7	8		7
Lampsilis sp.		3			
Lampsilis radiata	2	3			
Uniomerus tetralasmus					1
Anodonta sp.					5
Immature Unionidae	6	2	3	2	3

Table 5 (Continued)

Taxa	Station BS-1	BS-2	BS-3	BS-4	BS-5
Total Number Individuals	768	677	1023	643	965
Total Number Taxa	73	68	89	68	100
Annual Diversity ($\bar{d}$)	4.34	4.57	5.03	4.67	5.12

Table 6

Annual Numbers and Percent Composition of
Major Taxonomic Groups at Each Station
and All Stations Combined

Group		Station BS-1	BS-2	BS-3	BS-4	BS-5	Annual
Cnidaria	Number	1	2	3		1	7
	Percent	0.13	0.30	0.29		0.10	0.17
Nemertea	Number	1	3		1		5
	Percent	0.13	0.44		0.16		0.12
Oligochaeta	Number	16	139	256	202	160	773
	Percent	2.09	20.68	25.10	31.20	16.7	19.0
Hirudinea	Number		1	1		5	7
	Percent		0.15	0.10		0.52	0.17
Amphipoda	Number			15		10	25
	Percent			1.47		1.04	0.61
Decapoda	Number	1	4	5		10	20
	Percent	0.13	0.60	0.49		1.04	0.49
Hydracarnia	Number	4					4
	Percent	0.52					0.10
Collembola	Number			4		2	6
	Percent			0.40		0.21	0.15
Ephemeroptera	Number	49	60	92	23	55	279
	Percent	6.40	8.93	9.02	3.55	5.72	6.86
Odonata	Number	12	6	10	13	16	57
	Percent	1.57	0.89	0.98	2.01	1.66	1.40
Hemitera	Number				1		1
	Percent				0.16		0.02
Megaloptera	Number		1	2	1		4
	Percent		0.15	0.20	0.16		0.10
Trichoptera	Number	20	21	19	20	28	108
	Percent	2.61	3.13	1.86	3.09	2.91	2.65
Coleoptera	Number	43	25	26		30	124
	Percent	5.61	3.72	2.55		3.12	3.05

Table 6 (Continued)

Group		Station BS-1	BS-2	BS-3	BS-4	BS-5	Annual
Diptera	Number	606	391	547	381	618	2543
	Percent	79.04	58.12	53.62	58.89	64.41	66.55
Chironomidae	Number	412	293	462	321	540	2028
	Percent	53.72	43.60	45.29	49.61	56.30	49.89
Ceratopogonidae	Number	133	92	74	45	68	412
	Percent	17.36	13.62	7.25	6.96	7.08	10.13
Gastropoda	Number	4	4	29	2	10	49
	Percent	0.52	0.60	2.84	0.31	1.04	1.20
Pelecypoda	Number	13	15	11	2	12	53
	Percent	1.70	2.23	1.08	0.31	1.25	1.30

during January to 104 during April (Appendix B). Total number of individuals taken during each collection ranged from 477 during July, immediately following flood conditions, to 1537 in October (Appendix B). The reduced number of individuals in July can be attributed to scouring of the stream bottom during the flood, followed by high deposition.

The highest number of individuals collected at one station during a single collection was 429, from Station BS-3 during October (Table 7). The lowest number of individuals collected during a single collection was 39 at Station BS-1 in July. All stations had reduced numbers of individuals in July following a flood.

The number of taxa collected at one station during a collection ranged from 50 at Station BS-5 during April, to 10 at Station BS-1 during July. All stations, except BS-3, had reduced numbers of taxa in July following the flood.

Annually, Station BS-3 had the highest number of individuals, 1023 and Station BS-4 had the lowest, 643. Station BS-5 had the highest number of taxa, 100, while Stations BS-2 and BS-4 had the lowest, 68 (Table 5).

Of the 171 taxa collected, 41 were represented by only one specimen, comprising 23.8% of the total fauna. No large populations occurred for any taxa (Table 5).

The eurytolerant Limnodrilus hoffmeisteri, was the dominant oligochaete comprising 8.66% of the total fauna (Table 8). Annually this organism was dominant at Stations BS-2 and BS-3. Other important oligochaetes included Peloscolex sp. and Aulodrilus pigueti.

Mayflies were most abundant at Stations BS-2 and BS-3 comprising 8.93% and 9.02% of the total fauna (Table 6). The dominant mayfly was Hexagenia limbata, which was found at all stations. Most mayflies

Table 7

Variations in Numbers of Individuals, Taxa, and Diversity($\bar{d}$)

Collection Date		Station BS-1	BS-2	BS-3	BS-4	BS-5
October 11, 1980	Taxa	34	24	40	27	35
	Ind.	400	177	429	291	242
	$\bar{d}$	3.33	3.66	4.06	3.25	4.28
January 18, 1981	Taxa	33	31	38	25	34
	Ind.	185	205	235	137	186
	$\bar{d}$	3.78	3.28	4.19	3.90	4.15
April 11, 1981	Taxa	40	37	38	38	50
	Ind.	146	244	190	147	389
	$\bar{d}$	4.45	3.70	4.42	4.51	3.80
July 25, 1981	Taxa	10	22	39	21	41
	Ind.	39	51	169	71	147
	$\bar{d}$	2.48	4.17	4.30	3.65	4.53
Annual	Taxa	73	68	89	68	100
	Ind.	768	677	1023	643	965
	$\bar{d}$	4.34	4.57	5.03	4.67	5.12

Table 8

Annual Percent Composition of Macrobenthos for Each Station and All Stations Combined, Excluding Taxa which Constituted Less Than One Percent at Any Station

Organism	Station BS-1	BS-2	BS-3	BS-4	BS-5	Annual
Nais variabilis					1.2	0.39
Nais simplex					2.6	0.64
Pristina longisoma					1.0	0.24
Limnodrilus hoffmeisteri		14.3	15.6	7.1	4.7	8.66
Aulodrilus pigueti			1.6	3.2		1.08
Peloscolex sp.		5.2	5.4	15.0	1.6	5.04
Enchytraeus sp.				3.6		0.61
Eclipdrilus sp.					1.0	0.39
Lumbriculus variegatus			1.6		3.7	1.37
Gammarus sp.			1.5			0.39
Caenis sp.		2.1				0.86
Hexagenia limbata	3.7	2.7	3.1	1.5	1.1	2.43
Stenonema sp.		1.0	1.4			0.73
Neoephermera sp.			1.2			0.52
Hydropsyche sp.					1.2	0.42
Phylocentropus sp.		2.4	1.1		1.2	1.1
Dubiraphia sp.	5.5	2.7	2.2		2.1	2.5
Hexatoma sp.	7.8		1.0	1.9		2.2
Ablabesmyia cinctipes		1.0				0.41
Ablabesmyia annulata	1.3					0.66
Ablabesmyia tarella		1.3	1.3	1.5		1.08
Ablabesmyia ornata		2.0			1.1	0.96
Ablabesmyia mallochi		1.4				0.39
Polypedilum ontario			1.2			0.84
Polypedilum halterale			4.1	2.0	2.6	2.21
Polypedilum fallax			6.7	2.6	2.4	2.88
Tribelos fuscicornis		12.4	1.1		2.4	3.05
Cladotanytarsus sp.	19.8	3.7	4.6	11.1	1.7	7.67
Tanytarsus sp.	11.9	12.5	11.6	5.7	19.9	13.33
Pseudochironomus sp.	6.3		1.8			1.84
Zavrelia sp.		1.4				0.69
Stenochironomus sp.				1.4		0.44
Cryptochironomus fulvus			1.9		1.8	1.28
Leptochironomus sp.			1.8			0.66
Stictochironomus devinctus				1.4		0.22
Microtendipes sp.				7.0		1.65
Robackia demeijerei	2.3				2.2	1.06
Cricotopus remus	2.7		1.0	3.7	11.8	4.18
Cricotopus sp.1					1.0	0.27
Cricotopus fulvus				2.6		0.32
Palpomyia sp.	15.3	12.8	6.0	6.8	6.0	9.00
Palpomyia tibialis	1.3					0.27

Table 8 (Continued)

Organisms	Station BS-1	BS-2	BS-3	BS-4	BS-5	Annual
Amnicola sp.			2.5			0.84
Sphaerium sp.		1.0				0.64
Total Percent	77.8	79.8	80.9	80.7	74.5	78.6

were collected along the margins of the stream, associated with plant detritus.

Trichopterans were present at all stations. Phylocentopus sp. was the dominant trichopteran and was collected at all stations, except Station BS-4 (Table 5). It was most abundant in the January and April collections.

The only beetle found during all collections was the elmid, Dubiraphia sp. (Appendix B). It formed 8.4% of the total fauna during the October collection, but was never collected at Station BS-4.

The tipulid, Hexatoma sp., formed 2.2% of the total annual fauna, but was common only at Station BS-1 where it comprised 7.8% of the fauna and was found during all collections (Table 8, Appendix B).

The chironomids were the most abundant group of organisms collected. They occurred in relatively high numbers at all stations during the entire study. At Stations BS-1 and BS-5 chironomids formed over 50% of the entire fauna (Table 6), with Tanytarsus sp. being dominant, forming over 13% of the total fauna (Table 8). Other chironomids commonly found included Ablabesmyia spp., Polypedilum spp., Tribelos fuscicornis, Cladotanytarsus sp., Pseudochironomus sp., Cryptochironomus spp., Micotendipes sp., Robackia demeijerei, and Cricotopus spp.

The ceratopogonid, Palpomyia sp. was collected at all stations and was the second most abundant organism, comprising 9.0% of the total fauna (Table 8).

Shannon's diversity index ($\bar{d}$) ranged from 2.48 at Station BS-1 in July to 4.53 at Station BS-5 also in July (Table 7).

The diversity values obtained from this study are generally higher than those obtained from studies of other Big Thicket National Preserve streams (Table 9). Diversity values and annual numbers of taxa in

Table 9

Collections and Annual Comparison of Numbers of Taxa and $\bar{d}$ Values in Big Thicket Streams

Streams and Investigators	Total Taxa (Annual)	
Neches River (Harrel et al., 1976)	98	0.0 - 3.65 (1.19 - 3.89)*
Beech Creek (Kost, 1977)	172	3.22 - 4.62 (4.29 - 4.92)*
Village Creek (Lewis and Harrel, 1978)	143	0 - 4.50 (3.21 - 4.93)*
Village, Hickory, and Turkey Creek (Commander, 1980)	134	1.31 - 4.38 (2.34 - 3.67)*
Little Pine Island and Pine Island Bayou (Darville and Harrel, 1980)	123	1.16 - 3.87 (2.57 - 3.82)*
Menard Creek (Bass and Harrel, 1981)	125	1.22 - 3.99 (3.36 - 4.37)*
Big Sandy Creek (Present Study)	171	2.48 - 4.53 (4.34 - 5.12)*

*Annual $\bar{d}$ Values

Big Thicket streams are listed on Table 9.

Sorenson's (1948) index of similarity was used to compare faunal similarity between stations. The highest coefficient (0.65) was between Stations BS-1 and BS-2, while the lowest coefficient (0.46) was between Stations BS-1 and BS-4 (Table 10). Station BS-3 had the most taxa in common with other stations, while Station BS-4 had the least number of taxa in common with other stations. Station BS-4 had a completely different substrate and was in a much smaller stream, which may account for the diffrences.

Table 10

Annual Coefficients of Similarity Between Stations

Station	BS-1	BS-2	BS-3	BS-4	BS-5
BS-1					
BS-2	0.65				
BS-3	0.62	0.56			
BS-4	0.46	0.47	0.52		
BS-5	0.55	0.52	0.59	0.49	

SUMMARY AND CONCLUSIONS

Physicochemical conditions and benthic macroinvertebrates in streams of the Big Sandy Creek Unit of the Big Thicket National Preserve were studied from September, 1980 to August, 1981.

Physicochemical conditions indicated good water quality, with extremes of chemical parameters often coinciding with extremes of discharge.

No significant downstream trends occurred in the main stream in which Stations BS-1, BS-2, BS-3, and BS-5 were located. Significant differences in many physicochemical conditions existed between Station BS-4, located in a small tributary, and all other stations located in the main stream.

Water temperature varied from 6 C in January to 26 C in July, with only small fluctuations occurring between stations. Except for Station BS-5 in July, all stations had dissolved oxygen concentrations well above 50% saturation, which is suitable to support a diverse biota. All parameters were within the ranges expected for clean water streams in this region. The only physicochemical stress to the biota was due to variations in discharge that caused scouring of the stream bottom and deposition.

Bacteria contamination in the Big Sandy Creek was slight and should be safe for contact recreation. No downstream or seasonal trends were evident for numbers of fecal bacteria.

The FC/FS ratio of 59 out of 60 samples.was below 0.7 indicating contamination by warm-blooded animals other than human.

Only one sample had a FC/FS ratio above 0.7 indicating contamination by both animal and human fecal bacteria.

A total of 171 taxa and 4076 individuals were collected. Dominant organisms included Tanytarsus sp. (13.3%), Palpomyia sp. (9.0%), and Limnodrilus hoffmeisteri (8.66%). The greatest number of taxa, 50, occurred in April at Station BS-5, while the lowest, 10, occurred at Station BS-1 in July. The number of individuals varied erratically from station to station, and during different collections, being affected most by the amount of discharge.

Big Sandy Creek was characterized by high numbers of taxa and high $\bar{d}$ values. The one low $\bar{d}$ value was directly attributed to the July flood. The fauna of Big Sandy Creek was more similar to that of Beech Creek than other Big Thicket streams, being composed of large number of insects and small number of oligochaetes, (Kost, 1977).

The coefficient of similarity indicated that all stations were similar in faunal composition, except Station BS-4 which had a different substrate and was in a much smaller stream.

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APPENDIX A

PHYSICOCHEMICAL CONDITIONS IN BIG SANDY CREEK
ON SEPTEMBER 7, 1980, DURING
HIGH FLOW CONDITIONS

Parameter	Station BS-1	BS-2	BS-3	BS-4	BS-5
Temp C	24	24	24	22.2	24.5
O_2 mg/l	7.5	7.0	7.0	7.5	7.2
O_2 % Sat	90.9	84.9	84.9	88.2	88.0
BOD mg/l	1.9	1.8	1.3	0.5	1.7
CO_2 mg/l	5.5	5.5	5.5	13.0	5.0
Alk mg/l	10	9	12	5	8
pH	6.1	6.1	6.3	5.4	6.1
Spec Cond umhos/cm	83	75	61	19	50
Cl mg/l	15.0	15.0	11.5	9.5	9.5
Turbidity JTU	88	81	68	49	64
App Color CU	150	140	100	80	100
PO_4 mg/l	0.2	0.2	0.13	0.18	0.13
NH_4 mg/l	1.32	1.12	0.72	0.50	0.76
NO_3 mg/l	0	0	0	0.002	0
Total Iron mg/l	1.05	1.05	0.94	0.67	1.08
TSS mg/l	21	15	14	2	17
TDS mg/l	54	49	36	32	33
TDO mg/l	28	23	18	18	20
TDI mg/l	26	26	18	14	13
Chlor a mg/l	0	0	0	0	0

APPENDIX A (CONTINUED)

PHYSICOCHEMICAL CONDITIONS IN BIG SANDY CREEK
ON OCTOBER 11, 1980, DURING
LOW FLOW CONDITIONS

Parameter	Station BS-1	BS-2	BS-3	BS-4	BS-5
Temp C	18	17	17	17	17
O_2 mg/l	8.8	8.5	8.4	8.7	8.8
O_2 % Sat	95.9	90.7	89.7	92.9	93.9
BOD mg/l	2.1	1.9	0.9	1.6	0.7
CO_2 mg/l	7.0	5.5	5.0	11.5	4.0
Alk mg/l	10	16	12	4	10
pH	6.3	6.5	6.3	5.6	6.3
Spec Cond umhos/cm	61	71	60	28	53
Cl mg/l	13.5	14.5	13.5	10.0	12.5
Turbidity JTU	56	51	42	26	39
App Color CU	100	70	60	40	50
PO_4 mg/l	0.08	0.11	0.11	0.08	0.08
NH_4 mg/l	0.92	0.76	0.76	0.56	0.84
NO_3 mg/l	0	0	0	0	0
Total Iron mg/l	0.97	0.87	0.97	1.35	0.94
TSS mg/l	13	6	14	6	8
TDS mg/l	27	24	24	9	16
TDO mg/l	6	20	15	8	15
TDI mg/l	21	4	9	1	1
Chlor a mg/l	0	0	0	0	0

APPENDIX A (CONTINUED)

PHYSICOCHEMICAL CONDITIONS IN BIG SANDY CREEK
ON NOVEMBER 15, 1980, DURING
LOW FLOW CONDITIONS

Parameter	Station BS-1	BS-2	BS-3	BS-4	BS-5
Temp C	15.5	16	16	16	16
O_2 mg/l	7.6	7.7	7.7	7.9	8.3
O_2 % Sat	78.7	80.5	80.5	82.6	86.8
BOD mg/l	3.4	4.1	2.1	1.2	1.9
CO_2 mg/l	5.5	5.5	5.5	12.5	5.0
Alk mg/l	13	16	14	4	12
pH	6.1	6.4	6.4	5.5	6.1
Spec Cond umhos/cm	72	97	96	33	61
Cl mg/l	16.0	19.5	16.5	8.5	14.5
Turbidity JTU	47	44	36	32	36
App. Color CU	70	80	60	60	80
PO_4 mg/l	0.11	0.11	0.12	0.11	0.12
NH_4 mg/l	1.36	1.18	1.06	0.72	1.06
NO_3 mg/l	0.0	0.0	0.008	0.005	0.0003
Total Iron mg/l	0.73	0.71	0.61	0.49	0.94
TSS mg/l	1	3	2	3	3
TDS mg/l	30	41	33	19	31
TDO mg/l	24	30	20	12	16
TDI mg/l	6	11	13	7	15
Chlor a mg/l	0	0.01	0.01	0	0

APPENDIX A (CONTINUED)

PHYSICOCHEMICAL CONDITIONS IN BIG SANDY CREEK
ON DECEMBER 14, 1980, DURING
INTERMEDIATE FLOW CONDITIONS

Parameter	Station BS-1	BS-2	BS-3	BS-4	BS-5
Temp C	10.0	9.0	9.8	10.5	10.0
O_2 mg/l	9.8	10.2	10.1	9.1	10.2
O_2 % Sat	89.7	91.2	92.0	84.3	93.4
BOD mg/l	2.7	3.4	2.9	1.2	2.7
CO_2 mg/l	6.5	6.5	6.0	12.5	6.0
Alk mg/l	16	21	18	11	15
pH	5.6	5.4	5.6	4.7	5.1
Spec Cond umhos/cm	93	126	120	30	78
Cl mg/l	7.5	28.5	27.0	8.0	20.0
Turbidity JTU	65	44	39	30	39
App Color CU	140	50	30	20	100
PO_4 mg/l	0.84	0.16	1.80	0.17	0.09
NH_4 mg/l	0.76	0.79	0.89	0.58	0.76
NO_3 mg/l	0.002	0.001	0.003	0.005	0.00
Total Iron mg/l	0.55	0.60	0.64	0.28	0.60
TSS mg/l	6	5	1	5	9
TDS mg/l	35	51	45	13	31
TDO mg/l	18	6	16	2	10
TDI mg/l	17	45	29	11	21
Chlor a mg/l	0	0	0	0	0

APPENDIX A (CONTINUED)

PHYSICOCHEMICAL CONDITIONS IN BIG SANDY CREEK
ON JANUARY 18, 1981, DURING
LOW FLOW CONDITIONS

Parameter	Station BS-1	BS-2	BS-3	BS-4	BS-5
Temp C	6.0	6.1	6.0	9.2	7.0
O_2 mg/l	11.4	11.6	11.6	10.4	11.8
O_2 % Sat	94.5	96.4	96.2	93.4	100.0
BOD mg/l	3.9	3.9	3.5	2.2	3.7
CO_2 mg/l	3.5	4.0	3.5	9.5	2.5
Alk mg/l	12	17	14	4	11
pH	6.1	6.3	6.3	5.5	6.1
Spec Cond umhos/cm	82	144	128	30	400
Cl mg/l	16.5	33.0	29.0	9.0	19.5
Turbidity JTU	39	71	39	32	36
App Color CU	120	50	20	10	30
PO_4 mg/l	0.21	0.40	0.12	0.09	0.11
NH_4 mg/l	0.74	0.76	0.65	0.63	0.69
NO_3 mg/l	0.005	0.003	0.006	0.003	0.005
Total Iron mg/l	0.26	0.45	0.48	0.25	0.39
TSS mg/l	3	7	1	1	1
TDS mg/l	29	48	46	14	35
TDO mg/l	21	29	28	7	5
TDI mg/l	8	19	18	7	30
Chlor a mg/l	0	0.06	0.02	0	0.01

APPENDIX A (CONTINUED)

PHYSICOCHEMICAL CONDITIONS IN BIG SANDY CREEK
ON FEBRUARY 21, 1981, DURING
LOW FLOW CONDITIONS

Parameter	Station BS-1	BS-2	BS-3	BS-4	BS-5
Temp C	16	16.5	16.0	16.0	16.0
O_2 mg/l	6.6	7.0	6.6	7.0	7.8
O_2 % Sat	69.0	74.0	69.0	73.2	81.6
BOD mg/l	0.1	0.6	0	0.3	1.3
CO_2 mg/l	6.0	6.5	6.0	9.5	6.0
Alk mg/l	15	21	18	5	11
pH	6.8	5.9	5.9	5.4	6.9
Spec Cond umhos/cm	108	70	101	30	85
Cl mg/l	19.0	26.5	22.5	7.5	19.0
Turbidity JTU	56	51	54	42	56
App Color CU	130	110	150	100	50
PO_4 mg/l	0.28	0.18	0.52	0.29	0.28
NH_4 mg/l	0.60	0.58	0.52	0.37	0.52
NO_3 mg/l	0.004	0.005	0.005	0.004	0.004
Total Iron mg/l	0.80	0.78	0.67	0.09	0.64
TSS mg/l	4	2	9	2	6
TDS mg/l	40	49	39	24	40
TDO mg/l	21	17	23	11	12
TDI mg/l	19	32	16	13	28
Chlor a mg/l	0	0.01	0.01	0	0.02

APPENDIX A (CONTINUED)

PHYSICOCHEMICAL CONDITIONS IN BIG SANDY CREEK
ON MARCH 15, 1981, DURING
HIGH FLOW CONDITIONS

Parameter	Station BS-1	BS-2	BS-3	BS-4	BS-5
Temp C	15	14	14	15	14
O_2 mg/l	8.7	8.4	8.2	8.5	9.1
O_2 % Sat	89.1	84.2	82.2	87.1	91.2
BOD mg/l	0.8	0.3	0.2	0.2	0.6
CO_2 mg/l	6.5	7.5	7.0	9.0	6.5
Alk mg/l	19	23	19	7	17
pH	6.3	6.3	6.3	5.4	6.1
Spec Cond umhos/cm	108	114	98	29	75
Cl mg/l	19.5	23.0	19.0	9.0	16.0
Turbidity JTU	68	73	59	44	61
App Color CU	150	200	130	70	150
PO_4 mg/l	0.34	0.21	0.14	0.87	0.14
NH_4 mg/l	0.79	0.76	0.65	0.42	0.67
NO_3 mg/l	0	0.002	0.001	0.003	0.008
Total Iron mg/l	1.11	1.05	0.99	0.39	0.99
TSS mg/l	10	6	1	3	8
TDS mg/l	48	57	48	25	36
TDO mg/l	13	28	21	19	15
TDI mg/l	35	29	27	6	21
Chlor a mg/l	0.02	0	0.05	0.03	0

APPENDIX A (CONTINUED)

PHYSICOCHEMICAL CONDITIONS IN BIG SANDY CREEK
ON APRIL 11, 1981, DURING
LOW FLOW CONDITIONS

Parameter	Station BS-1	BS-2	BS-3	BS-4	BS-5
Temp C	21.0	20.5	21.0	20.0	20.0
O_2 mg/l	7.5	7.7	7.5	8.6	7.6
O_2 % Sat	86.4	87.9	86.4	97.3	86.0
BOD mg/l	1.5	1.2	0.7	0.9	1.1
CO_2 mg/l	6.5	8.5	7.5	11.0	7.0
Alk mg/l	24	29	23	5	16
pH	6.3	6.3	6.3	5.6	6.3
Spec Cond umhos/cm	101	134	121	30	104
Cl mg/l	19.0	27.5	25.0	9.0	23.5
App Color CU	140	70	90	40	90
Turbidity JTU	77	56	51	42	59
PO_4 mg/l	0.14	1.80	0.73	0.38	0.38
NH_4 mg/l	0.94	0.79	0.76	0.37	0.72
NO_3 mg/l	0.001	0.003	0.004	0.003	0.002
Total Iron mg/l	1.56	1.46	1.27	0.64	0.14
TSS mg/l	9	4	10	5	6
TDS mg/l	43	54	45	20	46
TDO mg/l	22	22	18	18	19
TDI mg/l	21	32	27	2	27
Chlor a mg/l	0.01	0.02	0.01	0.01	0.03

APPENDIX A (CONTINUED)

PHYSICOCHEMICAL CONDITIONS IN BIG SANDY CREEK ON MAY 9, 1981, DURING INTERMEDIATE FLOW CONDITIONS

Parameter	Station BS-1	BS-2	BS-3	BS-4	BS-5
Temp C	20	20	21	20	21
O_2 mg/l	7.1	7.3	5.5	8.2	7.6
O_2 % Sat	80.3	82.6	63.4	92.8	87.6
BOD mg/l	*	*	*	*	*
CO_2 mg/l	9.0	7.5	8.0	10.0	9.0
Alk mg/l	22	23	21	6	17
pH	5.6	5.6	5.6	4.5	6.1
Spec Cond umhos/cm	102	104	8.9	28.0	78
Cl mg/l	17.0	17.5	16.0	8.0	13.0
App Color CU	200	300	200	100	260
Turbidity JTU	95	104	104	56	106
PO_4 mg/l	1.51	2.37	0.97	1.39	0.61
NH_4 mg/l	1.60	1.56	1.69	0.46	1.64
NO_3 mg/l	0.006	0.005	0.002	0	0.004
Total Iron mg/l	0.28	0.26	1.47	0.46	0.40
TSS mg/l	30	30	35	3	38
TDS mg/l	54	53	50	21	50
TDO mg/l	32	23	26	19	21
TDI mg/l	22	30	24	2	29
Chlor a mg/l	0	0.02	0	0.01	0.01

* (incubator was out)

APPENDIX A (CONTINUED)

PHYSICOCHEMICAL CONDITIONS IN BIG SANDY CREEK
ON JUNE 16, 1981, DURING
FLOOD CONDITIONS

Parameter	Station BS-1	BS-2	BS-3	BS-4	BS-5
Temp C	25	25	25	23	25
O_2 mg/l	6.5	6.8	6.3	7.6	5.3
O_2 % Sat	80.2	83.9	77.7	90.7	65.4
BOD mg/l	0.3	0.8	0.5	0.2	1.6
CO_2 mg/l	10.5	10.0	12.0	14.5	16.5
Alk mg/l	24	25	22	4	19
pH	6.3	6.1	6.1	5.4	5.9
Spec Cond umhos/cm	107	115	102	21	77
Cl mg/l	14.5	17.5	16.5	9.0	11.0
App Color CU	250	240	240	170	260
Turbidity JTU	104	99	112	73	106
PO_4 mg/l	0.08	0.18	0.67	1.92	0.80
NH_4 mg/l	1.84	2.12	2.12	1.29	2.57
NO_3 mg/l	0	0	0	0.003	0.0001
Total Iron mg/l	0.26	0.32	1.35	0.53	0.40
TSS mg/l	29	24	24	9	45
TDS mg/l	56	54	50	21	41
TDO mg/l	34	18	31	15	24
TDI mg/l	22	36	19	6	17
Chlor a mg/l	0.01	0.01	0.02	0.01	0.02

APPENDIX A (CONTINUED)

PHYSICOCHEMICAL CONDITIONS IN BIG SANDY CREEK
ON JULY 25, 1981, DURING
HIGH FLOW CONDITIONS

Parameter	Station BS-1	BS-2	BS-3	BS-4	BS-5
Temp C	26	26	26	22	26
O_2 mg/l	6.1	5.8	5.3	5.8	3.6
O_2 % Sat	76.4	72.6	66.3	68.0	45.1
BOD mg/l	2.3	1.5	0.9	1.0	0.1
CO_2 mg/l	8.0	7.5	7.5	12.0	7.0
Alk mg/l	28	31	28	5	24
pH	6.3	6.3	6.3	5.5	6.8
Spec Cond umhos/cm	116	138	122	31	102
Cl mg/l	15.5	19.0	16.5	8.0	16.5
App Color CU	140	130	120	30	100
Turbidity JTU	65	75	61	39	64
PO_4 mg/l	1.8	1.8	1.64	0.42	2.77
NH_4 mg/l	1.03	0.89	0.89	0.48	0.89
NO_3 mg/l	0.005	0.005	0.005	0.004	0.004
Total Iron mg/l	0.22	0.13	0.22	0.17	0.24
TSS mg/l	5	5	14	7	11
TDS mg/l	47	56	58	22	42
TDO mg/l	19	25	23	11	20
TDI mg/l	28	31	35	11	22
Chlor a mg/l	0.02	0.01	0.03	0	0.02

APPENDIX A (CONTINUED)

PHYSICOCHEMICAL CONDITIONS IN BIG SANDY CREEK
ON AUGUST 26, 1981, DURING
LOW FLOW CONDITIONS

Parameter	Station BS-1	BS-2	BS-3	BS-4	BS-5
Temp C	25	24	24	22	25
O_2 mg/l	7.6	5.9	6.9	8.0	6.5
O_2 % Sat	93.7	71.5	83.6	93.8	80.2
BOD mg/l	0.9	*	0.9	0	*
CO_2 mg/l	6.0	6.5	9.0	10.0	6.0
Alk mg/l	18	22	19	4	17
pH	6.2	6.3	6.3	5.5	6.4
Spec Cond umhos/cm	81	95	79.5	30	78
Cl mg/l	13.0	14.0	12.5	9.0	12.5
App Color CU	110	90	90	80	120
Turbidity JTU	42	47	32	22	30
PO_4 mg/l	1.92	0.28	0.89	0.21	0.28
NH_4 mg/l	0.89	0.50	0.97	0.65	0.48
NO_3 mg/l	0.005	0.005	0.004	0.005	0.003
Total Iron mg/l	0.13	0.08	0.12	0.14	0.11
TSS mg/l	3	4	3	1	2
TDS mg/l	34	43	36	20	31
TDO mg/l	15	21	20	11	27
TDI mg/l	19	22	16	9	4
Chlor a mg/l	0	0	0	0.01	0

* (air in bottles)

APPENDIX B

NUMBERS OF BENTHIC MACROINVERTEBRATES
COLLECTED FROM BIG SANDY CREEK
ON OCTOBER 11, 1980

Taxa	Station BS-1	BS-2	BS-3	BS-4	BS-5
Annelida					
Oligochaeta					
Naididae					
Nais variabilis					2
Bratislavia unidentata					1
unk. Naididae				1	
Tubificidae					
Limnodrilus hoffmeisteri	5	8	48	30	18
Peloscolex sp.	1	32	41	94	4
Aulodrilus pigueti			12	18	
Lumbriculidae					
Eclipdrilus sp.				1	
Hirudinea					
Rhynchobdellidae					
Actinobdella triannulata			1		
Arthropoda					
Crustacea					
Decapoda					
Cambarellus puer					2
Hydracarnia					
unk. Hydracarnia	3				
Insecta					
Plecoptera					
Acroneuria sp.					3
Ephemeroptera					
Isonychia sp.	1				
Baetisca sp.	4				
Caenis sp.	6				8
Traverella sp.	3				
Parameletus sp.	2		2		2
Hexagenia limbata		6	21	5	1
Ametropus sp.				1	
Ephemerella sp.				1	
unk. Ephemeroptera			2		
Odonata					
Progomphus sp.	4				
Ophiogomphus sp.	2	2			
Macromia sp.			1		
Gomphus sp.			4	1	1

APPENDIX B (CONTINUED)

Taxa	Station BS-1	BS-2	BS-3	BS-4	BS-5
Amphiagrion sp.				2	
Boyeria sp.					2
Hemiptera					
Hebrus sp.				1	
Megaloptera					
Sialis sp.				1	
Trichoptera					
Hydropsyche sp.	4				11
Oxyethira sp.	1				
Stactobiella sp.				1	2
Orthotrichia sp.					1
Phylocentropus sp.		3	2		
Coleoptera					
Dubiraphia sp.	41	12	10		17
Stenelmis humorosa	1				
Stenelmis sinuata		2			
Diptera					
Tipulidae					
Hexatoma sp.	53	2	5		3
Pedicia sp.			1		
Chironomidae					
Tanypodinae					
Ablabesmyia cinctipes	1	7	2		
Ablabesmyia annulata				1	2
Ablabesmyia tarella		1	1	5	
Ablabesmyia mallochi			1		
Ablabesmyia ornata		2	2		1
Conchapelopia sp.	1				
Pentaneura sp.			1		1
Diamesinae					
Diamesa sp.			1		
Chironominae					
Polypedilum convictum	2				9
Polypedilum ontario	2	2	2		1
Polypedilum halterale	3		24	12	9
Tribelos fuscicornis			3		
Cladotanytarsus sp.	134	15	46	55	15
Tanytarsus sp.	21	14	89	24	17
Pseudochironomus sp.	16	4	16		1
Xenochironomus sp.	1				
Zavrelia sp.	1	2	1	2	
Microspectra sp.	2		3		
Stenochironomus sp.	1	5	1	2	
Paratanytarsus sp.	4	3			
Cryptochironomus blarina			2		
Cryptochironomus fulvus	1	3	10	8	4
Rheotanytarsus sp.		1			

APPENDIX B (CONTINUED)

Taxa					
Parachironomus sp.		1			
Glyptotendipes sp.			9		3
Cryptotendipes sp.			9		
Leptochironomus sp.			18		
Stictochironomus devinctus				2	
Robackia demeijerei					18
Orthocladiinae					
Cricotopus remus	14		2	5	42
Cricotopus sp. 1					10
Psectrocladius sp.	1				
Microcricotopus sp.	1		1		
Cardiocladius sp.				1	
Pseudorthocladius sp.				1	2
Ceratopogonidae					
Palpomyia sp.	61	45	27	15	23
Bezzia sp.	2	3	1		3
Culicoides sp.			1		
Mollusca					
Gastropoda					
Amnicola sp.			5		2
Pelecypoda					
Lampsilis sp.		2			
Uniomerus tetralasmus					1
Immature Unionidae			1	1	
Number of Individuals	400	177	429	291	242
Number of Taxa	34	24	40	27	35
Species Diversity ($\bar{d}$)	3.33	3.66	4.06	3.25	4.28

(total number individuals = 1537, total number taxa = 80)

APPENDIX B

NUMBERS OF BENTHIC MACROINVERTEBRATES
COLLECTED FROM BIG SANDY CREEK
ON JANUARY 18, 1981

Taxa	Station BS-1	BS-2	BS-3	BS-4	BS-5
Cnidaria					
Hydra sp.	1				
Nemertea					
Prostoma rubrum	1	1			
Annelida					
Oligochaeta					
Naididae					
unk. Naididae					1
Tubificidae					
Limnodrilus hoffmeisteri	1	84	21	10	11
Peloscolex sp.	2	3	2		4
Aulodrilus pigueti	2	4	1	1	
Lumbriculidae					
Eclipdrilus sp.			4		1
Hirudinea					
Immature Hirudinea		1			
Arthropoda					
Crustacea					
Amphipoda					
Gammarus sp.					
Decapoda					
Cambarellus puer	1	4	1		1
Insecta					
Plecoptera					
Isoperla sp.					1
Ephemeroptera					
Baetisca sp.		2			
Caenis sp.		2	2		
Traverella sp.			1		
Hexagenia limbata	19	10	2	5	9
Ephemerella sp.			5	1	3
Stenonema sp.		1			
Choroterpes sp.			4	5	
Baetis sp.			1		
Odonata					
Progomphus sp.	1				
Gomphus sp.			1		
Amphiagrion sp.				3	
Megaloptera					
Sialis sp.		1			

APPENDIX B (CONTINUED)

Taxa	Station BS-1	BS-2	BS-3	BS-4	BS-5
Trichoptera					
Oecetis sp.	1	1	1	2	
Triaenodes sp.				2	
Nyctiophylax sp.				1	
Pycnopsyche sp.					1
Ceraclea sp.				2	
Atopsyche sp.			1		
Phylocentropus sp.		12	4		3
Polycentropus sp.		1			
Coleoptera					
Dubiraphia	1	1	5		1
Tipulidae					
Hexatoma sp.	1		4	10	2
Tipula sp.				1	
Chironomidae					
Tanypodinae					
Ablabesmyia annulata	4		7	4	1
Ablabesmyia tarella			1		1
Ablabesmyia ornata				3	
Ablabesmyia mallochi				1	
Ablabesmyia parajanta		1			
Clinotanypus sp.			1		
Chironominae					
Polypedilum ontario	5	4	8		7
Polypedilum halterale			3		
Polypedilum fallax	1	6	61	10	23
Tribelos fuscicornis					22
Cladotanytarsus sp.	10	1	1		
Tanytursus sp.	48	23	12	4	24
Pseudochironomus sp.	24	3	2		1
Zavrelia sp.	3	3	2		1
Stenochironomus sp.				6	
Cryptochironomus blarina	6		8		
Cryptochironomus fulvus	1		9	1	13
Microtendipes sp.	1	1	4	28	4
Paratendipes connectens			1		3
Glyptotendipes sp.	1		1		1
Orthocladiinae					
Cricotopus remus	7		8	19	12
Cricotopus sp.					2
Brillia sp.		2			
Cricotopus sp 1.				1	
Pseudorthocladius sp.	1				
Orthocladius sp.	1				
Nanocladius sp.					1
Epoicocladius sp.					1

APPENDIX B (CONTINUED)

Taxa					
Ceratopogonidae					
Palpomyia sp.	22	26	18	13	22
Palpomyia tibialis	10	1			
Bezzia sp.	1		3		3
Stilobezzia			5		1
Tabanidae					
Tabanus sp.	1	1			
Mollusca					
Gastropoda					
Amnicola sp.	3		19		2
Gyraulus sp.	1				
Ferrissia sp.		1			
Pelecypoda					
Lampsilis radiata		2			
immature Unionidae	2	1		1	2
Number of Individuals	185	205	235	137	186
Number of Taxa	33	31	38	25	34
Species Diversity ($\bar{d}$)	3.78	3.28	4.19	3.90	4.15

(total number individuals = 948, total number taxa = 73)

APPENDIX B

NUMBERS OF BENTHIC MACROINVERTEBRATES
COLLECTED FROM BIG SANDY CREEK
ON APRIL 11, 1981

Taxa	Station BS-1	BS-2	BS-3	BS-4	BS-5
Cnidaria					
Hydra sp.		2	1		
Nemertea					
Prostoma rubrum		2		1	
Annelida					
Oligochaeta					
Naididae					
Nais variabilis	1			2	8
Nais simplex					24
Nais elinguis					1
Pristina breviseta				2	
Pristina longiseta leidyi				1	
Pristina longisoma					10
Pristina osborni					2
Dero nivea					1
Tubificidae					
Limnodrilus hoffmeisteri		1	41	1	9
Peloscolex sp.			2	1	7
Aulodrilus pigueti	1			2	
Tubifex sp.				3	1
Lumbriculidae					
Lumbriculus variegatus		3	8		1
Eclipdrilus sp.	1				
Enchytraeidae					
Enchytraeus	2			4	
Hirudinea					
Actinobdella triannulata					2
Arthropoda					
Crustacea					
Amphipoda					
Gammarus sp.			15		
Decapoda					
Cambarellus puer			4		
Hydracarina					
unk. Hydracarina	1				
Insecta					
Collembola					
Isotomurus palustris			4		2
Ephemeroptera					
Caenis sp.	1	6			

APPENDIX B (CONTINUED)

Taxa					
Hexagenia limbata	3	1	3		1
Stenacron sp.	1				
Parameletus sp.	3	4			
Choroterpes sp.		3			
Stenonema sp.		4	9	4	2
Leptophlebia sp.		1			
Neophemera sp.		2	7		
Cloeon sp.		2	2		
Heptagenia sp.			6		
Paraleptophlebia				1	
Leptohypes sp.			3		
Tricorythodes sp.					2
Baetis sp.					5
Odonata					
Progomphus sp.	1				
Amphiagrion sp.	2	1	1	1	
Macromia sp.	1				1
Gomphus sp.				1	
Boyeria sp.					1
Hagenius brevistylus					1
Trichoptera					
Hydropsyche sp.					1
Cheumatopsyche sp.			1		
Hydroptila sp.				1	
Oecetis sp.	3			2	
Nectopsyche sp.	1			1	
Trianodes sp.				1	
Molanna sp.				3	
Phylocentropus sp.	7		3		9
Nyctiophylax sp.				2	1
Polycentropus sp.	1				
Leptonema sp.	1				
Neureclipsis					1
Coleoptera					
Dubiraphia sp.		5	1		2
Ancyronyx variegata		3			1
Macronychus sp.					4
Stenelmis sp.					5
Diptera					
Tipulidae					
Hexatoma sp.	3		1	1	
Chironomidae					
Tanypodinae					
Ablabesmyia cinctipes	2			1	2
Ablabesmyia annulata	6	2			
Ablabesmyia tarella	5	8	11	5	2

APPENDIX B (CONTINUED)

Taxa					
Ablabesmyia ornata	1	11	3	4	11
Ablabesmyia mallochi		9			5
Ablabesmyia parajanta	1				
Ablabesmyia philosphagnos			1		
Conchapelopia sp.				2	
Pentaneura sp.	1				
Clinotanypus sp.	2				
Labrundinia neopilosella		2	1		
Chironominae					
Polypedilum ontario			1		1
Polypedilum fallax	1	1	7	7	
Polypedilum halterale	4	1	3		10
Tribelos fuscicornis	6	83	7	1	
Phaenospectra obediens	1		1		
Cladotanytarsus sp.	8	8		14	1
Tanytarsus sp.	21	47	12	27	146
Pseudochironomus sp.	7				6
Zavrelia sp.		4	3		5
Stenochironomus sp.				1	
Cryptochironomus blarina	1	1			
Cryptochironomus fulvus		2.			1
Rheotanytarsus sp.					7
Glyptotendipes sp.	1				3
Cryptotendipes sp.					1
Leptochironomus sp.		2		7	
Stictochironomus devinctus				7	
Microtendipes sp.	4	2	3	7	3
Robackia demeijerei	1		2		3
Chironomini (Sp. A) Roback					1
Orthocladiinae					
Cricotopus remus		2			59
Cricotopus fulvus			1	12	
Rheocricotopus sp.			2	2	1
Parametriocnemus sp.			1	5	
Ceratopogonidae					
Palpomyia sp.	29	9	13	7	8
Bezzia sp.	3	2	3	1	3
Mollusca					
Gastropoda					
Amnicola sp.			2		
Gyraulus sp.			1		
Ferrissia sp.				2	2
unk. limpet		1			
Pelecypoda					
Lampsilis radiata	1				
Lampsilis sp.		1			

APPENDIX B (CONTINUED)

Taxa	Station BS-1	BS-2	BS-3	BS-4	BS-5
Sphaerium sp.	3	5			3
Immature Unionidae	4				
Number of Individuals	146	244	190	147	389
Number of Taxa	40	37	38	38	50
Species Diversity ($\bar{d}$)	4.45	3.70	4.42	4.51	3.80

(total number individuals = 1116, total number taxa = 104)

APPENDIX B

NUMBERS OF BENTHIC MACROINVERTEBRATES
COLLECTED FROM BIG SANDY CREEK
ON JULY 25, 1981

Taxa	Station BS-1	BS-2	BS-3	BS-4	BS-5
Cnidaria					
Hydra sp.			2		1
Annelida					
Oligochaeta					
Naididae					
Nais variabilis				1	2
Nais simplex				1	1
Nais behningi			2		
Pristina osborni				2	
Bratislavia unidentata	1				
Tublificidae					
Limnodrilus hoffmeisteri		3	49	5	7
Peloscolex sp.			10	2	
Aulodrilus pigueti			3		
Tubifex sp.			4		
Enchytraidae					
Enchytraeus sp.				19	
Lumbriculidae					
Lumbriculus variegatus			8	1	35
Eclipdrilus sp.					9
Hirudinea					
Actinobdella triannulata					2
Helobdella punctatolineata					1
Arthropoda					
Crustacea					
Amphipoda					
Hyalella azteca					2
Crangonyx sp.					7
Decapoda					
Palaemonetes kadiiakensis					7
Insecta					
Plecoptera					
Atoperla ephyre				1	
Ephemeroptera					
Isonychia sp.		1			
Caenis sp.		6	3		1
Hexagenia limbata	6	1	6		
Stenonema sp.		2	5		3
Choroterpes sp.			2		
Neoephemera sp.		3	5		4

APPENDIX B (CONTINUED)

Taxa	Station BS-1	BS-2	BS-3	BS-4	BS-5
Cloeon sp.		2			
Paraleptophlebia sp.					7
Brachycercus sp.			1		
Callibaetis sp.					3
Odonata					
Progomphus sp.		1			1
Gomphus sp.			2		2
Macromia sp.					1
Boyeria sp.					1
Ischnura sp.		1		2	
Chromagrion conditum					5
Megaloptera					
Corydalus cornutus			2		
Trichoptera					
Hydropsyche sp.			1		
Oxyethira sp.			1		
Oecetis sp.	1	3	1	2	
Chimarra sp.			2		
Phylocentropus sp.		1	2		
Polycentropus sp.					1
Coleoptera					
Dubiraphia sp.			6		
Stenelmis sp.			4		
Ancyronyx variegata		2			
Diptera					
Hexatoma sp.	3			1	1
Chironomidae					
Tanypodinae					
Ablabesmyia cinctipes			1		1
Ablabesmyia tarella					4
Ablabesmyia ornata			2		
Ablabesmyia parajanta					2
Ablabesmyia philosphagnos				2	
Conchapelopia sp.			2		1
Pentaneura sp.			1		
Procladius sp.			1		
Chironominae					
Polypedilum ontario			1		
Polypedilum halterale		2	12	1	6
Polypedilum illinoense		1			5
Tribelos fuscicornus			1		1
Cladotanytarsus sp.		1		3	
Tanytarsus sp.	1	5	5	3	4
Pseudochironomus sp.	1				
Zavrelia sp.			1		
Stenochironomus sp.			2		

APPENDIX B (CONTINUED)

Taxa	Station BS-1	BS-2	BS-3	BS-4	BS-5
Rheotanytarsus sp.			3		
Paracladopelma sp.			1		
Microtendipes sp.				10	
Robackia demeijerei	17			2	
Orthocladiinae					
Metriocnemus sp.				1	
Krenosmittia sp.				1	
Ceratopogonidae					
Palpomyia sp.	7	6	3	9	5
Tabanidae					
Tabanus sp.		3		2	1
Haematopota sp.					2
Empididae					
unk. Empididae					
Mollusca					
Gastropoda					
Amnicola sp.					1
Ferrissia sp.		3	2		2
Viviparus sp.					1
Pelecypoda					
Lampsilis radiata	1	1			
Sphaerium sp.	1	2	8		4
Anodonta sp.					1
Immature Unionidae		1	2		1
Number of Individuals	39	51	169	71	147
Number of Taxa	10	22	39	21	41
Species Diversity ($\bar{d}$)	2.48	4.17	4.30	3.65	4.53

(total number individuals = 477, total number taxa = 80)